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Sir:

Transmitted herewith for filing is the patent application of

Inventor(s): Dan M. Griffin, Samuel C. Kingston, Delon K. Jones and Randal R. Sylvester

For: DIGITAL REVERSE TRANSMISSION FREQUENCY TRAINING METHOD FOR TIME DIVISION DUPLEX (TDD) COMMUNICATION SYSTEM

Enclosed are:

XXX Specification (11 pps); Claims (5 pps); Abstract (1pp);

XXX __2__ sheets of drawings;

XXX Declaration and Power of Attorney;

XXX An assignment of the invention to: **L-3 COMMUNICATIONS CORPORATION,** including $40.00 recordation fee and Assignment Recordation Form Cover Sheet;

____ Information Disclosure Statement (with copies of patent);

____ Form - PTO-1449;

____ Verified Statement Claiming Small Entity Status; and

____ Priority of U.S. Patent Application Serial No. _____, filed on is claimed under 35 U.S.C. §120.

The Filing Fee is calculated below.

CLAIMS AS FILED				
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Total Claims	16 - 20 =	0	x $18.00	$0
Independent Claims	3- 3 =	0	x $78.00	$0
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XXX The Commissioner is hereby authorized to charge any additional fees under 37 C.F.R. §§1.16 and 1.17 which may be required with this communication or during the entire pendency of the application, or credit any overpayment, to **Deposit Account No. 01-0467.** A duplicate copy of this Form is enclosed.

Address all future communications to: **Harry F.Smith, Esq.**
Ohlandt , Greeley, Ruggiero & Perle, L.L.P.
One Landmark Square, 9th Floor
Stamford,Connecticut 06901-2682
U.S.A.
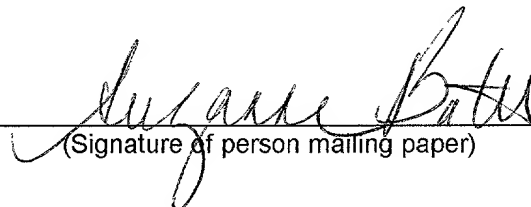**Telephone: (203) 327-4500**
Telefax: (203) 327-6401

October 24, 2000
Date of Signature

\Harry F. Smith, Esq.
Attorney for Applicant(s)
Ohlandt, Greeley, Ruggiero & Perle, L.L.P.
Registration No. 32,493
(203) 327-4500

CERTIFICATE OF EXPRESS MAILING

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Suzanne Bates
(Typed name of person mailing paper)

(Signature of person mailing paper)

Patent Application Papers of: Dan M. Griffin

Samuel C. Kingston

Delon K. Jones

Randal R. Sylvester

10   **DIGITAL REVERSE TRANSMISSION FREQUENCY TRAINING METHOD FOR TIME DIVISION DUPLEX (TDD) COMMUNICATION SYSTEM**

FIELD OF THE INVENTION:

This invention relates generally to Time Division Duplex (TDD) communication systems and, more particularly, relates

15   to TDD communication systems wherein bidirectional digital data links are established between an Access Point (AP) or Hub and a plurality of customer premise equipment (CPE).

BACKGROUND OF THE INVENTION:

In a TDD system two entities share a common carrier

20   frequency channel for conducting bidirectional communications. In order to avoid interference and collisions, a first entity transmits during a first time period while a second entity receives the transmission from the first entity, and then the second entity transmits

25   during a second time period while the first entity receives the transmission from the second entity. The first and second time periods are then repeated. In this manner it can be guaranteed that the two entities will not interfere with each others transmissions. Some amount of guard time

30   can be inserted between the first and second periods, and between periods, to ensure that one entity does not begin transmitting before the other finishes.

At the start of a transmission the receiving entity must acquire the received signal, resolve any frequency uncertainty and lock to the carrier frequency and carrier phase, and then begin demodulating the modulated carrier.

5　This can require some significant amount of time. Furthermore, the entire transmission might be missed if the receiver is unable to successfully acquire and lock to the received carrier during the transmission period.

As can be appreciated, it is desirable to provide an

10　ability to make the received signal acquisition and carrier frequency lock processes occur as rapidly as possible. One approach provides a synchronous timing scheme wherein the basic frequency references of both entities are, ideally, identical. For example, the frequency reference of the AP

15　or Hub is declared to be a master frequency reference, and the local frequency references of the CPEs are slaved to the AP frequency reference. Unfortunately, no frequency reference is ideal, and some drift can occur between the various frequency references of the CPEs and the AP. This

20　frequency drift causes a phase and frequency shift between the AP and a receiving CPE, which can lead to received signal demodulation errors.

OBJECTS AND ADVANTAGES OF THE INVENTION:

It is a first object and advantage of this invention to

25　provide a method and apparatus for providing an improved received signal acquisition and carrier frequency lock process.

It is another object and advantage of this invention to provide a method and apparatus for use in a communication

30　system that provides an improved received signal acquisition and carrier frequency lock process.

It is a further object and advantage of this invention to provide a method and apparatus for use in a TDD system that pre-corrects a frequency of a transmission from a transmitting entity so as to compensate for a detected

5   amount of frequency error between the transmitting entity and the receiving entity, thereby improving the ability of receiving entity to acquire, lock to, and demodulate the received transmission.

SUMMARY OF THE INVENTION

10   The foregoing and other problems are overcome and the objects of the invention are realized by methods and apparatus in accordance with embodiments of this invention.

A Time Division Duplex (TDD), Code Division Multiple Access (CDMA) communication system includes a plurality of

15   Customer Premises Equipment (CPE) and an Access Point (AP) that communicate through RF links. A CPE contains a receiver baseband subsystem and a transmitter baseband subsystem, and further contains receiver circuitry operable during a receive period for receiving an RF carrier from

20   the AP and for deriving a receiver tracking signal that is indicative of a frequency and phase shift between the received RF carrier and a reference signal. The receiver circuitry further includes a digital phase shifter and a frequency to phase accumulator that together rotate the

25   receiver baseband signal by some amount of frequency and phase and in a direction indicated by the receiver tracking signal. The CPE further contains, in accordance with an aspect of this invention, multiplexing circuitry for sharing the digital phase shifter and frequency to phase

30   accumulator circuits between the receiver baseband subsystem and the transmitter baseband subsystem. The frequency to phase accumulator is loaded during a next transmission period for operating the digital phase shifter

to correct a frequency of a transmitter baseband signal by an amount indicated by the receiver tracking signal, and in a direction opposite to the direction indicated by the receiver tracking signal. The effect is to pre-compensate an RF carrier that is transmitted to the AP from the CPE so as to reduce carrier acquisition time at a receiver of the AP.

The CPE may further contain sample and hold circuitry that is responsive to an end of the receive period for storing the receiver tracking frequency error. This stored frequency error is inverted and loaded into the frequency to phase accumulator which drives the digital phase shifter at the compensated frequency during the next transmission period.

BRIEF DESCRIPTION OF THE DRAWINGS

The above set forth and other features of the invention are made more apparent in the ensuing Detailed Description of the Invention when read in conjunction with the attached Drawings, wherein:

Fig. 1 is simplified block diagram of a TDD communication system having an AP and a plurality of CPEs that is suitable for practicing the teachings of this invention;

Fig. 2 is a circuit block diagram of a portion of one of the CPEs of Fig. 1, showing circuit components for pre-rotating a phase of a transmission to the AP in accordance with these teachings; and

Fig. 3 shows a TDD timing diagram that is useful in explaining the teachings of this invention.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 1 depicts a simplified block diagram of a TDD communication system 1 having an AP 12 and at least one, but preferably a plurality of CPEs 10, and that is suitable for practicing the teachings of this invention. The illustrated and presently preferred embodiment of the TDD communication system 1 operates as a Code Division Multiple Access (CDMA) type system that employs orthogonal codes, such as, but not limited to, Walsh-Hadamard codes, for spreading and despreading the communication signals transmitted between the CPEs 10 and the AP 12 over wireless links (WL) 11. However, other types of access systems may also benefit from the teachings of this invention, including Time Division Multiple Access (TDMA) and combined CDMA/TDMA type systems. In essence, the TDD communication system 10 may be considered to be a variant of a CDMA/TDMA system, as individual ones of the respective time divided transmissions between a given CPE 10 and the AP 12 are made using the CDMA spreading technique, wherein the transmitted waveform is spread over the available bandwidth using one or more properly selected spreading codes. Other types of communications systems may also benefit from the teachings of this invention.

Each CPE 10 is preferably comprised of a CDMA system 10A, assumed to generally include spreaders and despreaders, as well as data phase modulators (transmit), data phase demodulators (receive), frequency reference(s) such as local oscillators (LOs), carrier loop tracking circuits, possibly signal interleavers and deinterleavers, and other circuitry known to those skilled in this art. The CDMA system 10A is, however, modified in accordance with the teachings of this invention in a manner described below. The CDMA system 10A is coupled between a transceiver 10B and a suitable data processor 10C. The transceiver 10B is

preferably an RF transceiver providing wireless RF link 11 communication capabilities, preferably but not limited to line of sight (LOS) communication, with a similar RF transceiver 12B of the AP 12. However, in other embodiments

5 the transceivers 10B, 12B may be implemented as optical transceivers.

The data processor 10C could have the functionality of a conventional single user personal computer or workstation, and/or it may serve as a front-end for a local area network

10 (LAN) 18 having a plurality of data processors (DPs) 20 coupled thereto. The exact nature and use of the CPE 10 is not germane to an understanding of the teachings of this invention. It is noted that some or all of the CPEs may also have voice capability (e.g., a microphone and a

15 speaker), and that voice connections can also be made over the wireless links 11.

The Hub or Access Point (AP) 12 is similarly constructed to include a CDMA section 12A, preferably a multi-channel CDMA system for accommodating the plurality of CPEs 10, at least

20 one but preferably a plurality of the transceivers 12B for establishing the wireless links 11 with the CPEs 10, and an Access Point processor 12C for controlling the overall operation of the AP 12. The AP processor 12C is preferably bidirectionally coupled to at least one data communication

25 network 14 which, in turn, can provide access to the Internet and World Wide Web (WWW). In this manner, and by example, one of the DPs 20 can be used to access the WWW via the LAN 18, CPE 10, wireless link 11, AP 12 and the data communication network 14.

30 During operation, a local oscillator of the AP 12 is preferably frequency and phase synchronous with a local oscillator of the CPE 10. However, some amount of frequency and phase shift between the two LOs will

typically be present. A phase shift may also be introduced due to RF channel impairments between the AP 12 and the CPE 10. As such, at least the CPE 10 is provided with carrier loop tracking circuitry (not shown) for frequency and phase
5   locking the local oscillator of the CPE 10 to the incoming received carrier signal from the AP 12.

Referring to Fig. 2, there is shown a portion of the CDMA system 10A of one of the CPEs 10. The upper part of the drawing shows a portion of the conventional receiver
10   baseband circuitry or subsystem while the lower part shows a portion of the transmitter baseband circuitry or subsystem, in accordance with these teachings.

Referring first to the upper part of Fig. 2, the receiver (RX) includes Inphase (I) and a Quadrature (Q) baseband
15   channels that are obtained from the RF transceiver 10B. The I and Q channels are essentially mirror images and include an analog to digital (A/D) converter 22A, 22B, DC offset removal circuitry 24A, 24B and (optional) filters 26A, 26B. Conventionally, the outputs of the filters 26A
20   and 26B would be applied to the corresponding I and Q inputs of a digital phase shifter (DPS) 28. The DPS 28, during the receive period, operates to rotate the frequency and phase of the I and Q signals by an amount indicated by the output of a frequency to phase accumulator (FPA) 44.
25   The FPA 44 is driven by an output of a carrier loop tracking circuit. The output of the DPS 28 are signals representing rotated I and Q signals that are applied to a despreader 30 and subsequent baseband circuitry. The despreader 30 is used to extract the CPE's signal from the
30   received signal and to then pass the received signal on to a data decoder and related circuitry.

The FPA 44 basically functions as an accumulator that adds the value output by a sample and hold (S/H) 42 each clock period, thereby changing the phase that the DPS 28 receives each clock to produce a frequency correction. The
5   combination thus corrects for a small frequency error. The frequency generated is given by:

fo = ((clock frequency) X S/H value)/Length of accumulator,

e.g., 2^{32} if a 32-bit accumulator is used.

In accordance with this invention an input multiplexer
10   (MUX) 32 is provided at the frontend of the DPS 28. The MUX 32 is controlled with a transmit/receive (XMIT/RCV) signal so as to couple, during the TDD receive period and in a conventional fashion, the received baseband I and Q signals to the input of the DPS 28. From the output of the
15   DPS 28 the rotated signals are applied to the despreader 30.

A frequency/phase loop filter that forms a part of the carrier loop tracking circuit contains a measure of the receive frequency error and also the phase error of the
20   received signal. At the end of a receive burst the receive frequency error is held by the sample and hold (S/H) 42, inverted and applied to the frequency to phase accumulator 44. This signal then drives the digital phase shifter 28 to generate a frequency opposite to that of the receive
25   frequency error, thus pre-correcting a transmitted frequency error. As such, when the AP 12 receives the CPE 10 transmission the CDMA system 12A can more rapidly and reliably carrier lock to the received CPE signal, and then despread and demodulate the received signal.

30   The output of the DPS 28 is provided to I and Q filters 40A, 40B, respectively, and then to transmit path I and Q

digital to analog converters (D/As) 40C, 40D, respectively. These signals are subsequently upconverted to the desired transmission carrier frequency.

Referring now as well to Fig. 3, it can be seen that the
5   TDD waveform contains a plurality of transmit periods interspersed with a plurality of receive periods. The transmit and receive periods may or may not be of the same duration. During the receive period the carrier loop tracking circuit is operative to maintain the CPE 10 LO
10   locked to the received carrier. The amount and direction of the frequency shift that is required to be corrected (the amount required to maintain lock) can be indicated by an analog or a digital signal. This signal is then used by the FPA 44 and the DPS 28 as described above.

15   In accordance with the teachings of this invention the disclosed circuitry of the MUX 32 cooperates with the DPS 28, the frequency to phase accumulator 44, and the output signal (receiver tracking signal) of the carrier loop tracking circuit to correct the frequency of the
20   transmitter baseband I and Q channels.

To facilitate this operation the sample and hold (S/H) circuit 42 can be provided if the output signal of the carrier loop tracking circuit is an analog signal. If the output signal of the carrier loop tracking circuit is
25   instead a digital signal, then the sample and hold function can be implemented with a simple register or with a memory location for storing the last value of the receiver tracking signal during the next transmission period.

In operation, the output signal of the carrier loop
30   tracking circuit is sampled during the receive period and passed through to the frequency to phase accumulator 44. The last frequency-only component of the loop filter is

then inverted and held at the end of the receive period or
burst. While being held the inverted signal is applied to
the frequency to phase accumulator 44, which drives the DPS
28 to create a correction frequency, for the duration of

5   the transmit period.   In this manner the amount of
frequency correction applied by the DPS 28 to the
transmitter baseband I and Q channels, during a single
transmission period, is a function of the amount of
frequency error detected by the carrier loop tracking

10 circuit at the end of the previous receive period. The use
of a single value for the frequency correction during the
transmission period is possible since the transmit and
receive periods are typically much shorter than the time
over which the signal propagation of the RF channel

15 changes, and are also typically shorter than the time over
which the CPE 10 LO drifts by a significant amount with
respect to the AP 12 LO. In the preferred embodiment of
this invention the transmit and receive periods each have
a typical duration in the range of about 0.5 milliseconds

20 to about 4 milliseconds, a period of time that is typically
much smaller than signal propagation time constants
experienced in the RF channel, such as slow fades, which
can be seconds and tens of seconds, and is also smaller
than the typical (short term) LO drift rate.

25 The use of this invention enables the AP 12 to more quickly
acquire the carrier phase from the CPE 10, as the frequency
error has been substantially removed. This enables the
transmitted signal to arrive at the AP 12 with little or no
frequency ambiguity due to RF channel impairments and

30 frequency-influencing conditions that may exist between the
CPE 10 and the AP 12, such as frequency shifts between the
CPE 10 and AP 12 LOs. As such, non-coherent clocks may be
employed between the CPE 10 and the AP 12, thus simplifying
the overall system design and operation.

While the invention has been particularly shown and described with respect to preferred embodiments thereof, it will be understood by those skilled in the art that changes in form and details may be made therein without departing

5   from the scope and spirit of the invention. For example, while Fig. 2 shows the preferred embodiment wherein the DPS 28 is time multiplexed between the transmit and receive channels using the MUX 32, in other embodiments of this invention the MUX 32 could be eliminated, and a second DPS

10 32 provided in the transmit path. Thus, this invention should not be construed to be limited by only the illustrated and above-described embodiments, but should be given a scope commensurate with the scope of the following claims.

CLAIMS

What is claimed is:

1. A method for operating a communication device, comprising steps of:

during a receive period,

receiving a first carrier and deriving a receiver tracking signal that is indicative of a frequency shift between the received first carrier and a reference signal; and

shifting a receiver baseband signal by an amount and in a direction indicated by the receiver tracking signal; and

during a next transmission period,

shifting a transmitter baseband signal by an amount indicated by the receiver tracking signal during the receive period, and in a direction opposite to the direction indicated by the receiver tracking signal during the receive period; and

transmitting a second carrier signal that is modulated in accordance with the shifted transmitter baseband signal.

2. A method as in claim 1, wherein the steps of shifting comprise time multiplexing a digital phase shifter circuit between a receiver baseband subsystem and a transmitter baseband subsystem.

3. A method as in claim 1, wherein the carrier conveys a CDMA communication signal.

4. A method as in claim 1, wherein a TDD communication device comprises Customer Premises Equipment (CPE), and where the carrier is received from a transmitter of an Access Point (AP).

5. A method as in claim 1, wherein at the end of the receive period a step is performed of storing the receiver tracking signal for use during the next transmission period.

6. A method as in claim 1, wherein the step of shifting the transmitter baseband signal functions to pre-compensate the transmitted second carrier signal so as to reduce carrier acquisition time at a receiver of the transmitted second carrier signal.

7. A communication device comprising a receiver baseband subsystem and a transmitter baseband subsystem, and further comprising:

a receiver comprising circuitry that is operable during a receive period for receiving a carrier and for deriving a receiver tracking signal that is indicative of a frequency and phase shift between the received carrier and a reference signal, said receiver further comprising circuitry for rotating the frequency and phase of a receiver baseband signal by an amount and in a direction indicated by the receiver tracking signal; and

a transmitter comprising circuitry that is operable during a next transmission period for generating a frequency for a transmitter baseband signal that is

shifted by an amount indicated by the receiver tracking signal, and in a direction opposite to the direction indicated by the receiver tracking signal.

8. A communication device as in claim 7, wherein said shifting circuitry of said transmitter and said receiver comprises a frequency to phase accumulator circuit and a digital phase shifter circuit, and circuitry for time multiplexing said frequency to phase accumulator circuit and said digital phase shifter circuit between said receiver baseband subsystem and said transmitter baseband subsystem.

9. A communication device as in claim 7, wherein the carrier conveys a CDMA communication signal.

10. A communication device as in claim 7, wherein said communication device is a TDD communication device and comprises Customer Premises Equipment (CPE), and where the carrier is received from a transmitter of an Access Point (AP).

11. A communication device in claim 7, and further comprising sample and hold means responsive to an end of the receive period for storing the receiver tracking signal for use during the next transmission period.

12. A Time Division Duplex (TDD) Code Division Multiple Access (CDMA) communication system comprising a plurality of Customer Premises Equipment (CPE) and an Access Point (AP) that communicate through RF links, wherein a CPE comprises a receiver baseband subsystem and a transmitter baseband subsystem and further comprising:

receiver circuitry operable during a receive period for receiving an RF carrier from the AP and for

deriving a receiver tracking signal that is indicative of an error between the received carrier and a reference signal, said receiver circuitry further comprising a digital phase shifter for correcting the frequency and phase of a receiver baseband signal by an amount and in a direction indicated by the receiver tracking signal;

multiplexing circuitry for sharing said digital phase shifter between said receiver baseband subsystem and said transmitter baseband subsystem; and

transmitter circuitry operable during a next transmission period for operating said digital phase shifter to correct the frequency of a transmitter baseband signal by an amount indicated by the receiver tracking signal, and in a direction opposite to the direction indicated by the receiver tracking signal, for pre-compensating an RF carrier that is transmitted to said AP so as to reduce carrier acquisition time at a receiver of the AP.

13. A TDD system in claim 12, wherein said CPE further comprises a frequency to phase accumulator having an input coupled to receive said receiver tracking signal and an output coupled to a control input of said digital phase shifter.

14. A TDD system in claim 12, wherein said CPE further comprises a frequency to phase accumulator having an input coupled to receive said receiver tracking signal and an output coupled to a control input of said digital phase shifter, wherein said multiplexing circuitry shares both said frequency to phase accumulator and said digital phase shifter between said receiver baseband subsystem and said transmitter baseband subsystem.

15. A TDD system in claim 13, wherein said CPE further comprises circuitry responsive to an end of the receive period for storing the receiver tracking signal for use by said digital phase shifter during the next transmission period.

16. A TDD system in claim 12, wherein said CPE further comprises circuitry responsive to an end of the receive period for storing the receiver tracking signal and for inverting said stored receiver tracking signal for use by said digital phase shifter during the next transmission period.

DIGITAL REVERSE TRANSMISSION FREQUENCY TRAINING METHOD FOR TIME DIVISION DUPLEX (TDD) COMMUNICATION SYSTEM

ABSTRACT OF THE DISCLOSURE

A Time Division Duplex (TDD), Code Division Multiple Access (CDMA) communication system includes a plurality of Customer Premises Equipment (CPE) and an Access Point (AP) that communicate through RF links. A CPE contains a receiver baseband subsystem and a transmitter baseband subsystem, and further contains receiver circuitry operable during a receive period for receiving an RF carrier from the AP and for deriving a receiver tracking signal that is indicative of a frequency and phase shift between the received RF carrier and a reference signal. The receiver circuitry further includes a frequency to phase accumulator (FPA) and a digital phase shifter (DPS) for correcting the frequency and phase of a receiver baseband signal by an amount and in a direction indicated by the receiver tracking signal. The CPE further contains multiplexing circuitry for sharing the FPA and DPS circuitry between the receiver baseband subsystem and the transmitter baseband subsystem. Also contained in the CPE is transmitter circuitry operable during a next transmission period for operating the FPA and DPS circuitry to correct the frequency of a transmitter baseband signal by an amount indicated by the receiver tracking signal, and in a direction opposite to the direction indicated by the receiver tracking signal. The effect is pre-compensate an RF carrier that is transmitted to the AP from the CPE so as to reduce carrier acquisition time at a receiver of the AP. The CPE further contains sample and hold circuitry that is responsive to an end of the receive period for storing the receiver tracking signal for use by the FPA and DPS circuitry during the next transmission period.
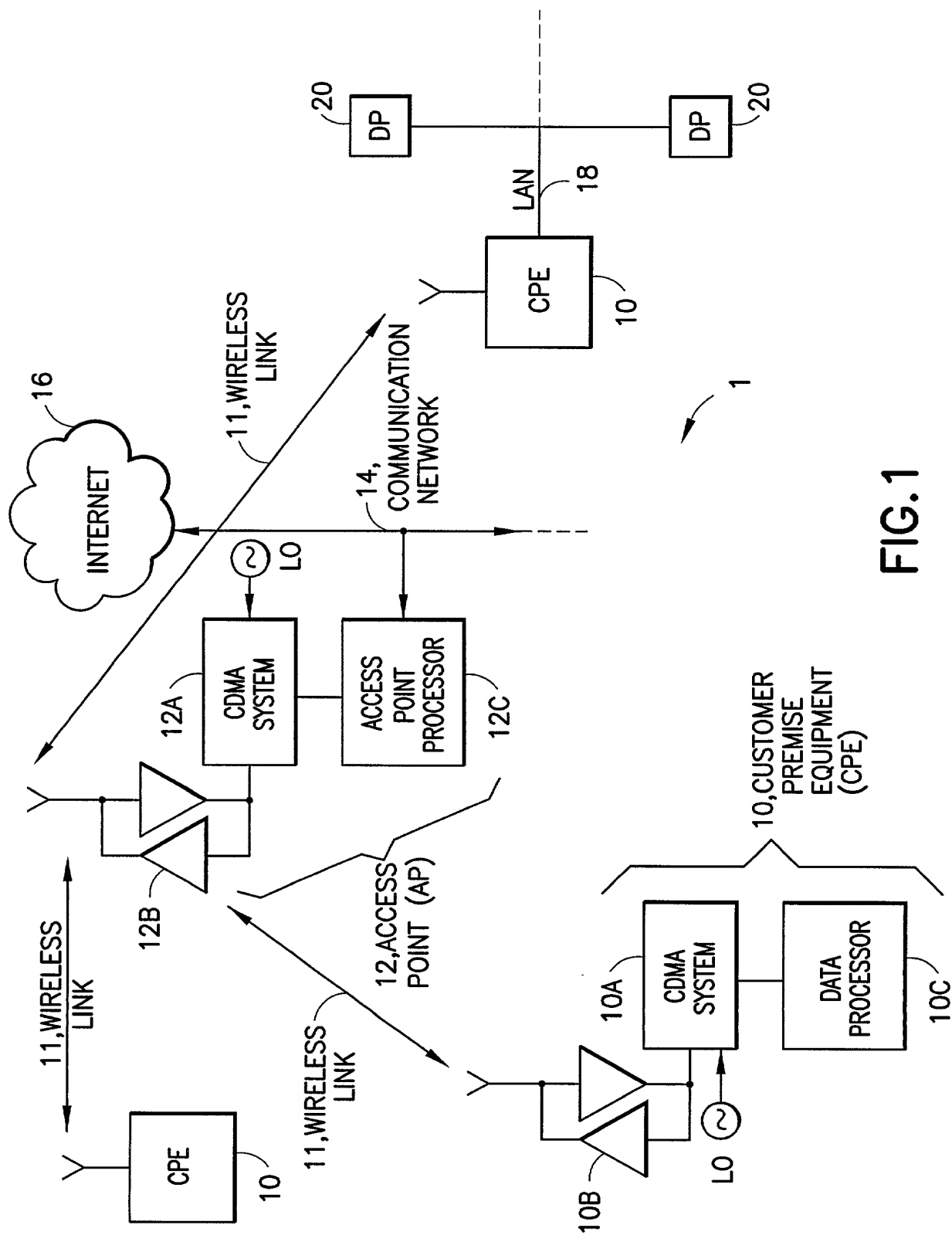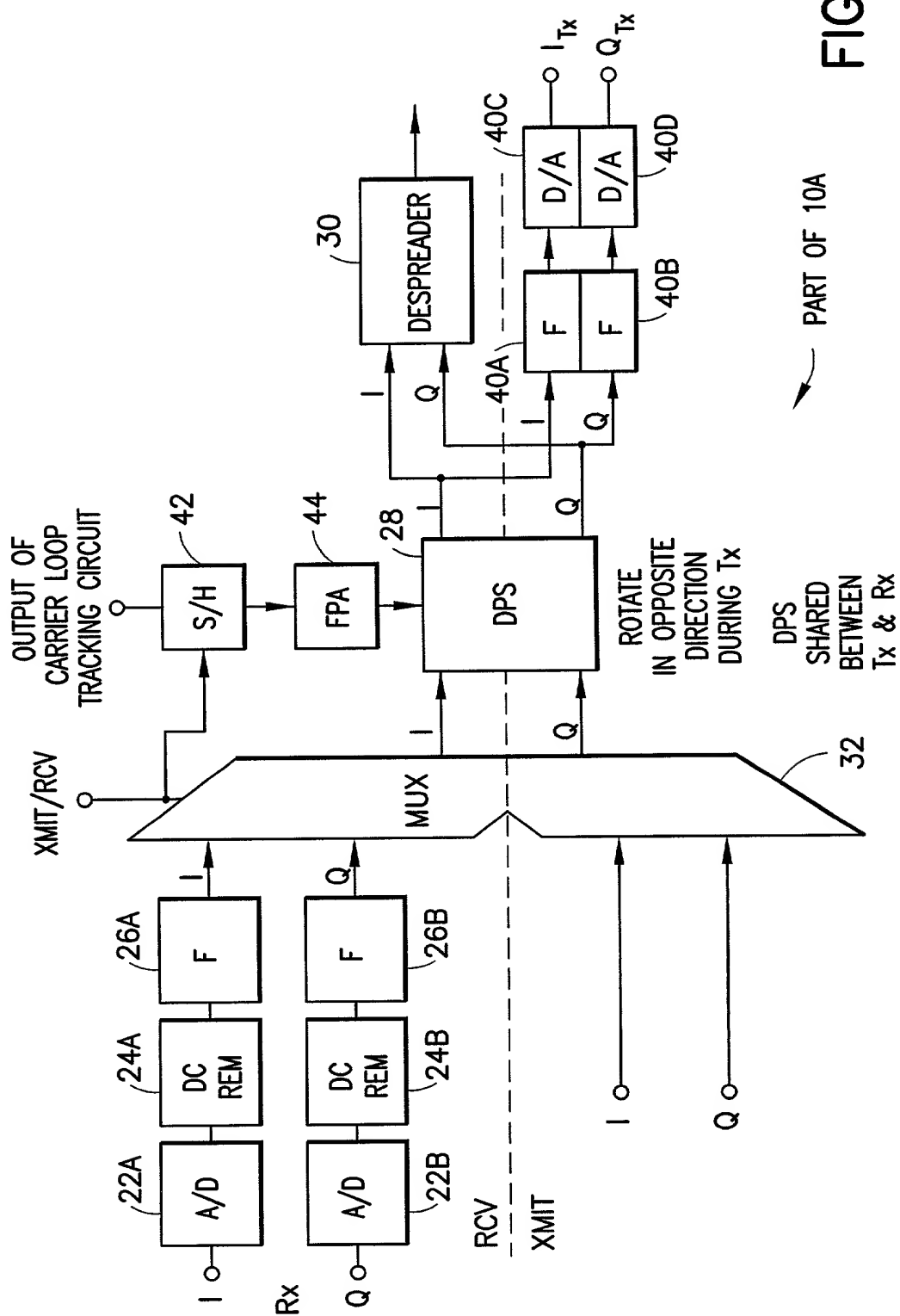
FIG.1

FIG.2

Rx

I → 22A A/D → 24A DC REM → 26A F → I →

Q → 22B A/D → 24B DC REM → 26B F → Q →

RCV / XMIT

XMIT/RCV

OUTPUT OF CARRIER LOOP TRACKING CIRCUIT → 42 S/H → 44 FPA → 28 DPS

MUX → 32

I

Q

ROTATE IN OPPOSITE DIRECTION DURING Tx

DPS SHARED BETWEEN Tx & Rx

30 DESPREADER →

I

Q

40A → F → 40B F → 40C D/A → I_{Tx}

40D D/A → Q_{Tx}

PART OF 10A

FIG.3

RCV | XMIT | RCV | XMIT

SAMPLE | HOLD | SAMPLE | HOLD
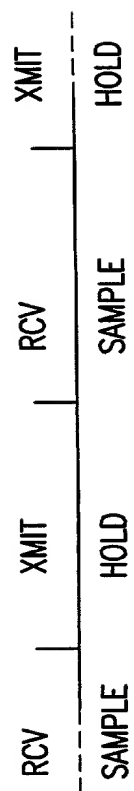
DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

<div align="right">Docket No.<u>907.0009USU</u></div>

As below named inventors, we hereby declare that:

Our residences, post office addresses and citizenships are as stated below next to our respective names.

We believe we are the original, joint inventors of the subject matter which is claimed and for which a patent is sought on the invention entitled:

<div align="center">

DIGITAL REVERSE TRANSMISSION FREQUENCY TRAINING METHOD FOR TIME DIVISION DUPLEX (TDD) COMMUNICATION SYSTEM

</div>

the specification of which

        (check one)   **X**   is attached hereto.

            _____ was filed on _____ as Application Serial No._____
            and was amended on _____(if applicable).

We hereby state that we have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

We acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to us to be material to the patentability of this application as defined in Title 37, Code of Federal Regulations, §1.56.

We hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate(s) listed below and have also identified below any foreign application(s) for patent or inventor's certificate(s) having a filing date before that of the application on which priority is claimed:

<u>Prior Foreign Application(s)</u>   <u>Priority Claimed</u>

                                                    ___ Yes ___ No

(Number)	(Country)	(Day/Mon/Year Filed)

                                                    ___ Yes ___ No

(Number)	(Country)	(Day/Mon/Year Filed)

We hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, we acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

<div align="center">1</div>

| (Application Serial No.) | (Filing Date) | (Status - patent, pend., abandon) |

| (Application Serial No.) | (Filing Date) | (Status - patent, pend., abandon.) |

POWER OF ATTORNEY: As named inventors, we hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

NAMES	REGISTRATION NUMBERS
Harry F. Smith	32,493
Paul D. Greeley	31,019
Charles N.J. Ruggiero	28,468

SEND CORRESPONDENCE TO:	DIRECT TELEPHONE CALLS TO:
Harry F. Smith, Esq. Ohlandt, Greeley, Ruggiero & Perle, L.L.P. One Landmark Square, 9th Floor Stamford, Connecticut 06901-2682	Harry F. Smith, Esq. Telephone: (203) 327-4500 Telefax: (203) 327-6401

We hereby declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

FULL NAME OF INVENTOR	LAST NAME **GRIFFIN**	FIRST NAME **DAN**	MIDDLE NAME **M**
RESIDENCE & CITIZENSHIP	CITY **BOUNTIFUL**	STATE OR COUNTRY **UTAH**	CITIZENSHIP **USA**
POST OFFICE ADDRESS	P.O. ADDRESS **1086 OAKRIDGE LANE**	CITY & STATE **BOUNTIFUL, UTAH**	ZIP CODE **84010**

Inventor's signature _____ Date __10/16__, 2000

DAN M. GRIFFIN

2

Date: _Oct   4_ , 2000 _Samuel C. Kingston_
By: Samuel C. Kingston

STATE OF _Utah_)
) SS
COUNTY OF _Salt Lake City_)

NOTARY PUBLIC
Karen A. Broadhead
640 North 2200 West
Salt Lake City, Utah 84116
My Commission Expires
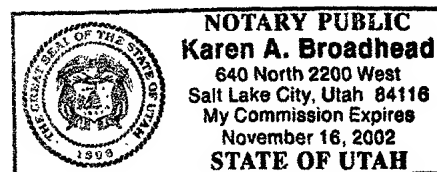November 16, 2002
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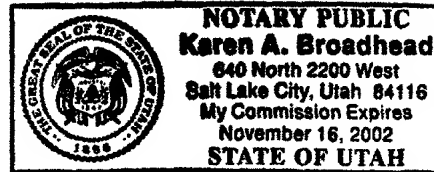
Sworn to before me this _4th_ day of _October_, 2000.

Karen A. Broadhead
Notary Public

Date: _Oct 16_ , 2000 _Delon K. Jones_
By: Delon K. Jones

STATE OF _Utah_)
) SS
COUNTY OF _Salt Lake City_)

NOTARY PUBLIC
Karen A. Broadhead
640 North 2200 West
Salt Lake City, Utah 84116
My Commission Expires
November 16, 2002
STATE OF UTAH

Sworn to before me this _16th_ day of _October_, 2000.
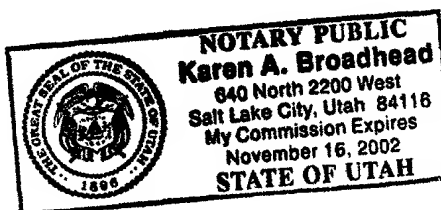
Karen A. Broadhead
Notary Public

3

Date: _October 4_, 2000

By: Randal R. Sylvester

STATE OF Utah)
) SS
COUNTY OF SLC)

Sworn to before me this 4th day of October, 2000.

Notary Public

NOTARY PUBLIC
Karen A. Broadhead
640 North 2200 West
Salt Lake City, Utah 84116
My Commission Expires
November 16, 2002
STATE OF UTAH

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